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Tuesday 10 November 2020 ± Morning

GCSE (9–1) Combined Science (Chemistry) A (Gateway Science)

J250/03 Paper 3 (Foundation Tier)

Time allowed: 1 hour 10 minutes



You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science (Chemistry) A (inside this document)

You can use:
- a scientific or graphical calculator
- an HB pencil



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

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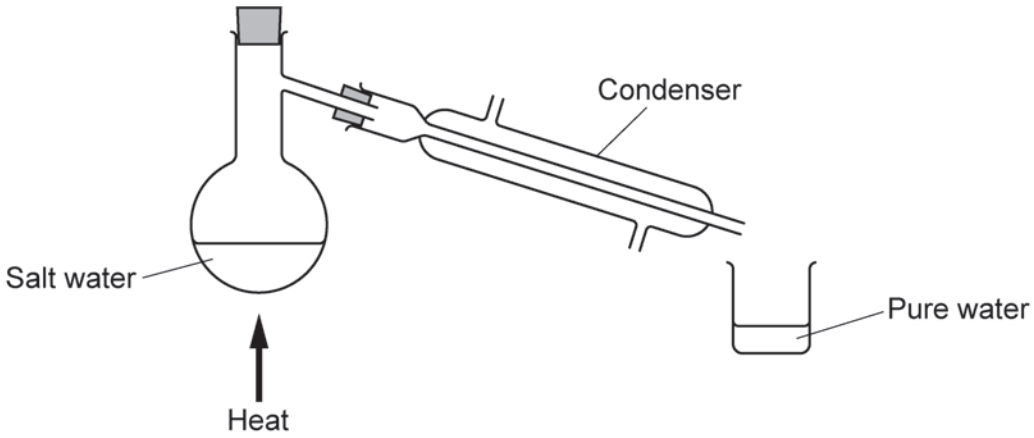
SECTION A

Answer **all** the questions.

You should spend a maximum of 20 minutes on this section.

Write your answer to each question in the box provided.

1 The diagram shows how pure water can be separated from salt water by simple distillation.



Which **two** changes of state happen during simple distillation?

A Condensation and freezing

B Evaporation and condensation

C Freezing and evaporation

D Melting and freezing

Your answer ☐ **[1]**

2 Look at the information about four different substances, **A**, **B**, **C** and **D**.

Substance	Melting point (°C)	Conducts electricity?
A	–30	no
B	3550	no
C	1660	yes
D	124	no

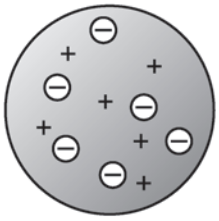
Which substance is **diamond**?

Your answer ☐ **[1]**

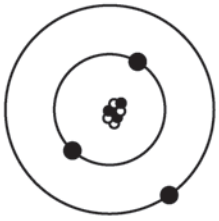
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3 The diagrams show three different models of the atom.

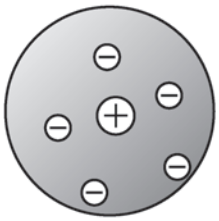
1



2



3



What is the correct order for the development of the three models, starting with the **earliest**?

A 1, 3, 2

B 1, 2, 3

C 3, 1, 2

D 3, 2, 1

Your answer ☐ **[1]**

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4 Which particle in a solution of dilute hydrochloric acid, HCl, makes it acidic?

A Cl^-

B H^+

C H_2O

D OH^-

Your answer ☐ **[1]**

5 The electrolysis of aluminium oxide, Al_2O_3, makes aluminium, Al, and oxygen, O_2.

$2Al_2O_3 \longrightarrow 4Al + 3O_2$

Which statement about electrolysis is correct?

A The masses of aluminium and oxygen formed are the same.

B The mass of aluminium decreases.

C The mass of aluminium oxide increases.

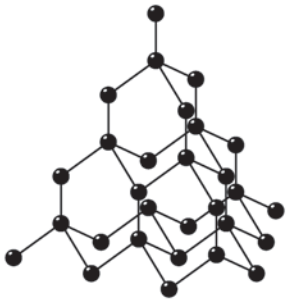
D The mass of oxygen increases.

Your answer ☐ **[1]**

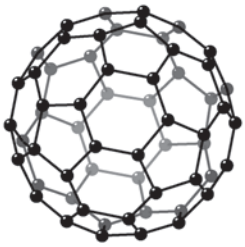
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6 The diagrams show different structures of carbon.

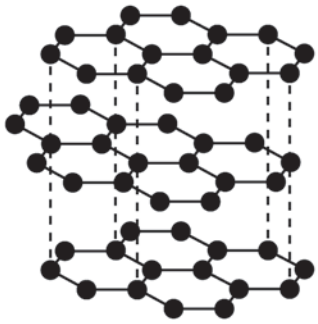
A



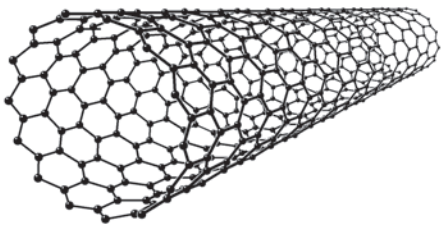
B



C



D

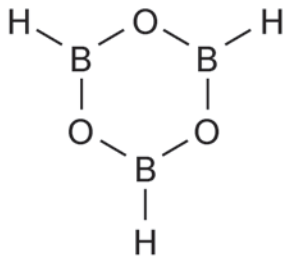


Which structure is Buckminsterfullerene?

Your answer ☐ **[1]**

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7 Look at the molecule below.



What is the **empirical formula** of the molecule?

A BHO

B BHO_2

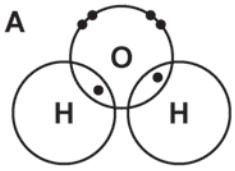
C $B_3(OH)_3$

D $B_3H_3O_3$

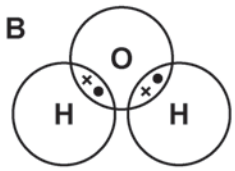
Your answer ☐ **[1]**

8 The bonding in a water molecule, H_2O, can be shown by a dot and cross diagram.

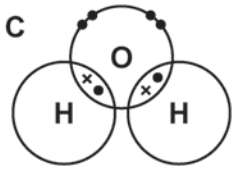
A



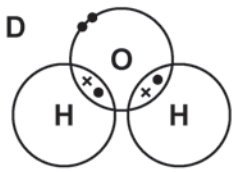
B



C



D



Which is the correct dot and cross diagram for water?

Your answer ☐ **[1]**

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9 Iron can be made from the reaction of iron(III) oxide with carbon monoxide.

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

What is the **reducing agent** in this reaction?

A CO

B CO_2

C Fe

D Fe_2O_3

Your answer ☐ **[1]**

10 Look at the information about a nitrogen atom.



How many **electrons** are in a nitride ion, N^{3-}?

A 4

B 10

C 11

D 17

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

11 Magnesium is a metal in Group 2 and Period 3 of the Periodic Table.

Fig. 11.1 shows the arrangement of electrons in an atom of magnesium.

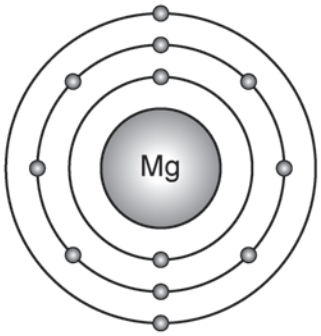


Fig. 11.1

(a) What is the approximate size of an atom of magnesium?

Tick (✓) **one** box.

1.6×10^{-15} m ☐

1.6×10^{-10} m ☐

1.6×10^{-5} m ☐

[1]

(b) Explain why magnesium is found in Group 2 and Period 3 of the Periodic Table.

Use **Fig. 11.1** to help you.

.....

.....

.....

..... **[2]**

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(c) Magnesium reacts with oxygen, O_2, to form magnesium oxide, MgO.

(i) Complete the **balanced symbol** equation for the reaction of magnesium with oxygen.

..... Mg + O_2 → ..... MgO

[2]

(ii) Explain how an atom of magnesium reacts to form a magnesium ion.

Use **Fig. 11.1** to help you.

.....

.....

..... **[2]**

(d) Magnesium exists as isotopes.

Look at the information about two atoms of magnesium.

$^{24}_{12}Mg$ $^{25}_{12}Mg$

(i) Explain why these two atoms are isotopes of magnesium.

.....

.....

.....

..... **[2]**

(ii) Complete the table to show the number of **protons** and **neutrons** in each isotope of magnesium.

Isotope	Number of protons	Number of neutrons
$^{24}_{12}Mg$		
$^{25}_{12}Mg$		

[2]

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12 A student investigates the temperature change in an exothermic reaction.

Look at **Fig. 12.1**. It shows his experiment.

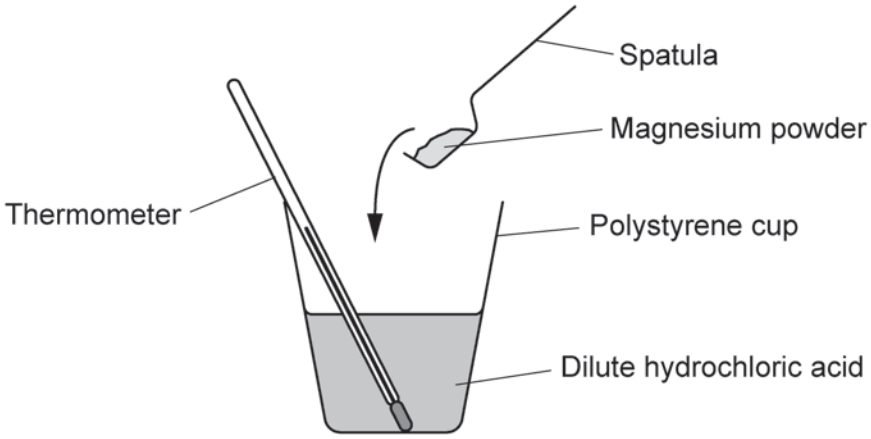


Fig. 12.1

This is the method the student follows:

- Measure 25 cm^3 of dilute hydrochloric acid into a polystyrene cup.
- Measure the temperature of the acid.
- Add 1 small spatula of magnesium powder and stir the mixture.

(a) What piece of equipment should the student use to measure an **accurate** volume of 25 cm^3 of dilute hydrochloric acid?

..... **[1]**

(b) Look at **Fig. 12.2**. It shows part of the thermometer used to measure the temperature of the dilute hydrochloric acid at the start of the experiment.

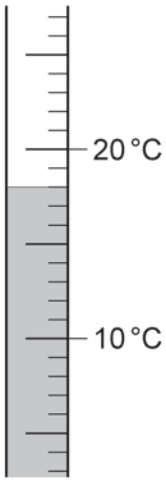


Fig. 12.2

What is the temperature shown on the thermometer?

..... **[1]**

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(c) The student's method is incomplete.

(i) Describe what the student should do next to prove that the reaction is exothermic.

.....

..... **[1]**

(ii) Predict the result the student would obtain.

..... **[1]**

(d) Why was the temperature change measured by the student **less** than he expected?

Tick (✓) **one** box.

Some heat escaped from the top of the polystyrene cup. ☐

The thermometer was left in the dilute hydrochloric acid for too long. ☐

Too much magnesium powder was added to the dilute hydrochloric acid. ☐

[1]

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(e) Look at **Fig. 12.3**. It shows the reaction profile for an exothermic reaction.

E_a is the activation energy.

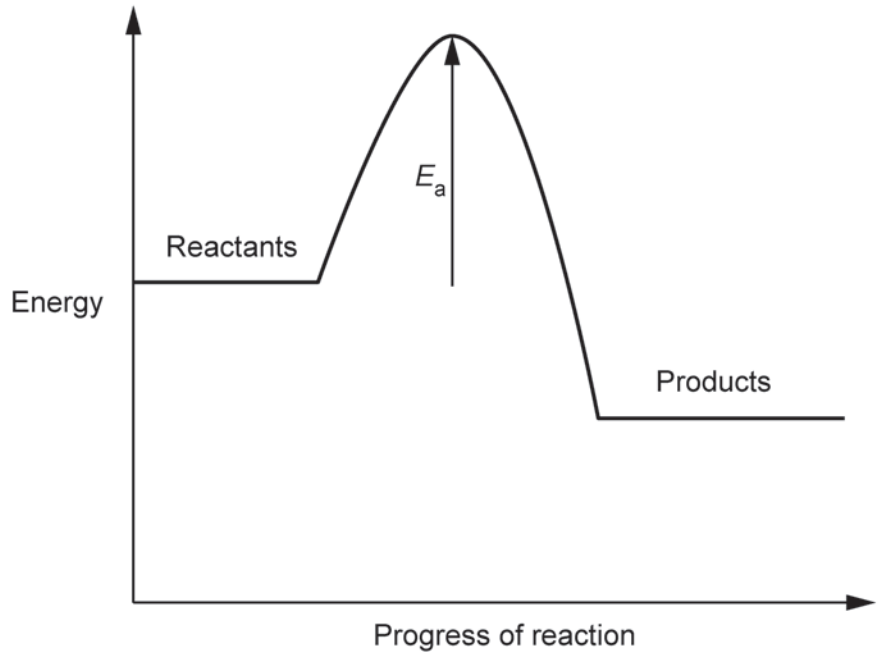


Fig. 12.3

(i) Describe how the reaction profile shows that this reaction is **exothermic**.

.....

..... **[1]**

(ii) What is meant by **activation energy**?

.....

..... **[1]**

(f) When magnesium reacts with dilute hydrochloric acid, a gas is produced.

(i) What is the name of the gas produced?

..... **[1]**

(ii) Describe the test and result for the gas named in **(f)(i)**.

Test .....

Result ..... **[2]**

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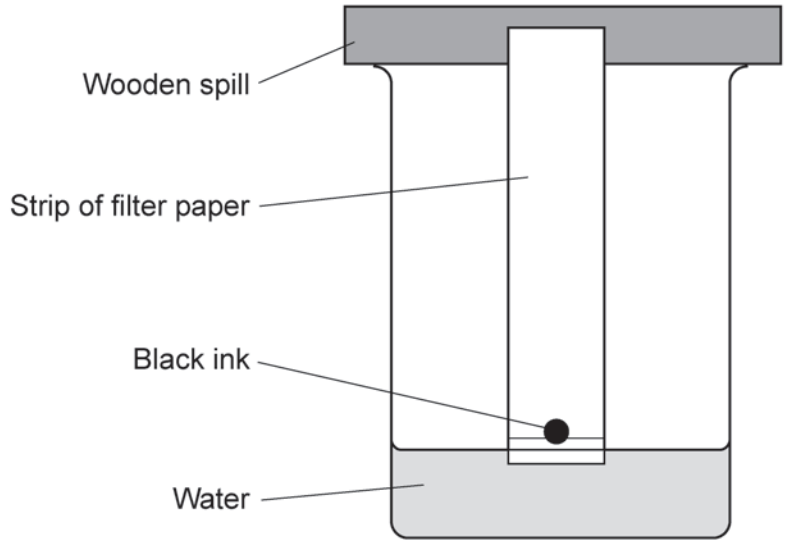
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Turn over for question 13

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13 A student investigates which colour dyes are found in a black ink.

Look at the diagram. It shows her experiment.



The black ink separates into five different colours.

The student calculates an ***R*_f value** for each colour in the black ink.

Look at **Table 13.1**. It shows the student's R_f values.

Colour	***R*_f value**
purple	0.24
green	0.38
orange	0.49
red	0.75
yellow	0.89

Table 13.1

(a) What is the name of this method of separation?

Tick (✓) **one** box.

Chromatography ☐

Crystallisation ☐

Distillation ☐

Filtration ☐

[1]

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(b) (i) What is the **mobile phase** in the experiment?

..... **[1]**

(ii) Give a reason why the student chose the substance in **(b)(i)** as the mobile phase.

.....

..... **[1]**

(c) The student knows that the R_f value of a **different** dye is 0.46.

She thinks that this R_f proves that the dye is the same orange dye found in the black ink.

Do you agree with the student?

Yes ☐

No ☐

Give a reason for your answer using information from **Table 13.1**.

.....

.....

..... **[1]**

(d) Another student repeats the experiment but uses a pure blue ink.

He measures the distance travelled by the blue ink and the water.

Look at **Table 13.2**. It shows his results.

	Distance travelled (mm)
Blue ink	21
Water	53

Table 13.2

Calculate the R_f value of the blue ink.

Give your answer to **2** significant figures.

R_f value of the blue ink = ... **[3]**

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14* This question is about ionic and simple covalent compounds.

Look at the information about two compounds, **Y** and **Z**.

	Compound Y	**Compound Z**
Appearance at room temperature	white solid	colourless liquid
Melting point (°C)	807	–95
Boiling point (°C)	1465	69
Electrical conductivity	conducts electricity as a molten liquid but not as a solid	does not conduct electricity

Use the information in the table to state if **Y** and **Z** are ionic or simple covalent compounds.

Explain your decision using ideas about structure and bonding.

.....

.....

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..... **[6]**

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15 Mendeleev published a Periodic Table in 1871.

Look at the diagram. It shows a version of Mendeleev's Periodic Table.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
H							
Li	Be	B	C	N	O	F	
Na	Mg	A*l*	Si	P	S	C*l*	
K Cu	Ca Zn		Ti	V As	Cr Se	Mn Br	Fe Co Ni
Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	I	Ru Rh Pd

Describe how the Periodic Table on the separate Data Sheet is an improvement on Mendeleev's Periodic Table.

Use information from **both** Periodic Tables in your answer.

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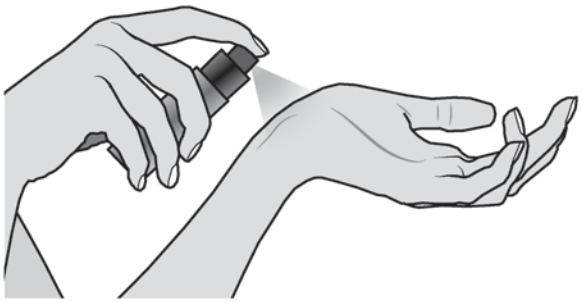
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..... **[4]**

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16 People use perfumes to make them smell nice.



Look at the table. It shows the percentages of the different ingredients in a perfume.

Ingredient	Percentage (%)
fragrance	5.2
alcohol	74.8
colour	0.5
UV filter	0.5
water	added to make up to 100%

(a) What is the name given to a mixture, such as perfume, where the ingredients are combined in exact amounts?

..... **[1]**

(b) A bottle contains 25 g of the perfume.

Calculate the mass of water in 25 g of the perfume.

Mass of water in 25 g of perfume = ... **[2]**

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(c) When the perfume is sprayed onto the skin, the alcohol evaporates very quickly.

(i) Suggest why the alcohol evaporates very quickly.

.....

..... **[1]**

(ii) As the alcohol evaporates, the skin starts to feel cold.

Explain why.

Use ideas about energy in your answer.

.....

.....

.....

..... **[2]**

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17 This question is about compounds of magnesium.

(a) Magnesium hydroxide contains magnesium ions, Mg^{2+}, and hydroxide ions, OH^-.

Write the **formula** of magnesium hydroxide.

..... **[1]**

(b) Magnesium carbonate, $MgCO_3$, reacts with dilute hydrochloric acid, HCl.

Magnesium chloride, $MgCl_2$, water and carbon dioxide are made.

Write the **balanced symbol equation** for the reaction.

..... **[2]**

(c) A compound of magnesium contains an unknown element, **X**.

X is an element found in Group 7 of the Periodic Table.

The compound has the formula $Mg\mathbf{X}_2$.

The relative formula mass of the $Mg\mathbf{X}_2$ is 184.1.

(i) Calculate the relative atomic mass of **X**.
A_r Mg = 24.3

Relative atomic mass of **X** = ... **[2]**

(ii) Identify element **X**.

Use the Periodic Table on the Data Sheet to help you.

..... **[1]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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